

Case report

Burns caused by fan heater used for managing post-operative hypothermia in a premature neonate

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Abstract

Generally fan forced area heaters are considered to be incapable of causing burn injury. A case is presented where such a heater was used to prevent post-operative hypothermia after cut-back anoplasty to correct low anorectal malformation (imperforate anus) in a premature neonate. The neonate sustained dermo-epidermal (second degree) burns to the abdominal wall and right forearm which were swaddled with cloth and deep (third degree) burns to the fingers of left hand that were exposed as intravenous line was inserted at dorsum of the hand.

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1. Introduction

Maintaining core body temperature is an important aspect of anesthetic management. A number of strategies are utilized to prevent hypothermia in the anesthetized patient. These include the use of heating pads, heating lamps, heated humidifiers, circulating-water mattresses, forced-air warming blankets, bags of warm intravenous fluids, and warm plastic bottles with pads. There are few reports in the literature regarding injuries due to failure or misapplication of these devices.¹ The present case illustrate the unique danger of using fan forced area heater to manage post-operative hypothermia and the knowledge among medical staff about heat and its mechanism of causation of injuries.

2. Case report

A premature female neonate born at gestational age of approximately seven months had low anorectal malforma-

tion (imperforate anus). At neonatal age of one day she underwent cut-back anoplasty under general anesthesia and the surgery lasted for approximately 30 minutes. After the procedure she was taken to surgical intensive care unit for post-operative monitoring with instructions to administer oxygen by using hood and to prevent hypothermia. On admission to the intensive care unit she was conscious, crying, responding to stimuli, the heart rate was 110/min, respiratory rate was 30/min and SpO₂ was 98%. She was swaddled with cotton cloth and kept at head end of the bed designated for use by adults. The needle for intravenous fluid administration was inserted at dorsum of left hand, and thus this portion was out of the swaddled cloth. The head of the neonate was kept under the oxygen hood. To manage hypothermia a portable fan forced area heater (also called a warmer among medical staff) was kept at the foot end of the bed about 3 ft away from the baby with hot air directed towards the neonate. The fan heater operates at 220 V alternating current and has three power and control settings (Fig. 1). When the “Warm” and “Hot” buttons are pressed, the fan and heating elements operate at 2000 W and 1000 W, respectively. When the “Cool” button is

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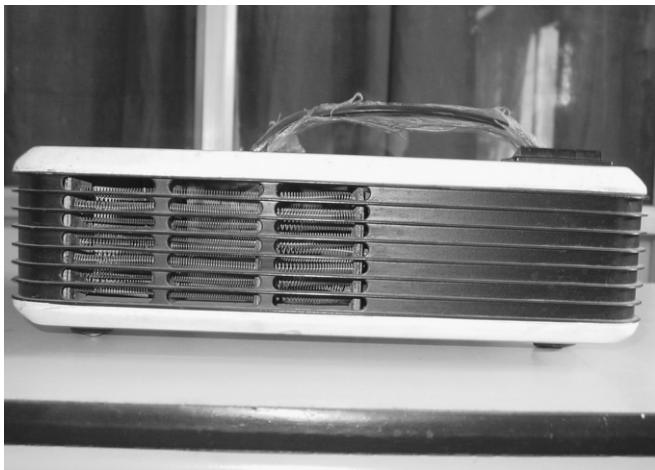


Fig. 1. The appliance which caused the injury – portable fan heater.

pressed the heating elements are off and the fan circulates room air only. The neonate was exposed to warm air for about an hour when the medical staff noticed redness over left hand. The general condition of the neonate had deteriorated. She was febrile to touch, had respiratory distress with central cyanosis, and heart sounds were indistinct with heart rate of 140/min. Resuscitative efforts were initiated including artificial respiration and cold sponges. Subsequently her general condition improved.

Following injuries were sustained by the neonate:-

- (1) Dermo-epidermal (second degree) burn over anterior abdominal wall measuring 4 in. \times 5 in. (Fig. 2).
- (2) Dermo-epidermal (second degree) burn over extensor surface of right forearm and wrist measuring $3\frac{1}{2}$ in. \times $1\frac{1}{2}$ in. (Fig. 3).
- (3) Deep (third degree) burns to multiple fingers of left hand. These included entire thumb and index finger, distal and middle phalanges of middle finger and distal phalanx of ring finger (Fig. 4).
- (4) Dermo-epidermal (second degree) burn over palmar aspect of distal phalanx of left little finger (Fig. 4).



Fig. 2. Burn injury to abdomen (photograph taken on 11th day after the incidence).



Fig. 3. Burn injury to posterior aspect of right forearm (photograph taken on 11th day after the incidence).



Fig. 4. Burn injury to fingers of left hand (photograph taken on 11th day after the incidence).

The cloth used for swaddling did not sustain any damage. Few days later the middle and distal phalanges of left index and middle finger had auto-amputated and there were scars related to burns over posterolateral aspect of right forearm, left thumb and tip of left ring finger.

Following reasons were stated by the medical and paramedical staff for using fan heater:

- (A) No prior incidence of similar injury when the fan heater was used for managing post-operative hypothermia.
- (B) For adult patient the fan heater was routinely placed on a trolley which was kept at the bed side. The trolley height was 3 ft more than the bed. In the present circumstances, since the neonate was kept at head end of the bed, the fan heater was kept at the foot end of the bed. It was presumed that a distance of 3 ft between the neonate and heater would be enough to avoid direct exposure to the heat.

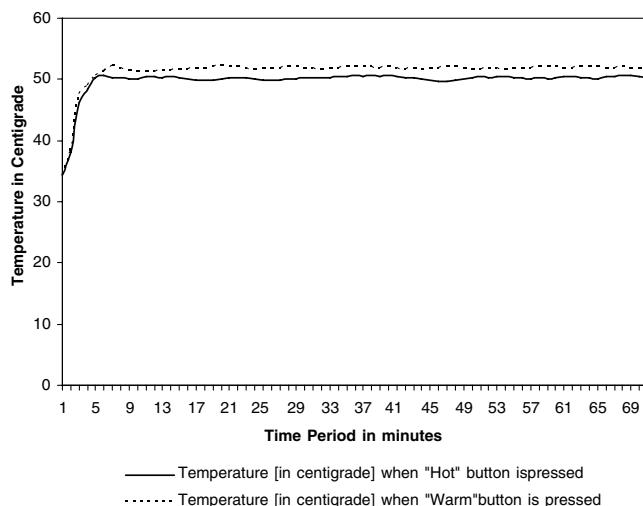


Fig. 5. Temperature recorded at the distance of 3 ft when the hot air blow directed to the probe of thermometer.

(C) It was postulated that by swaddling the neonate with cotton cloth direct exposure to hot air was prevented.

The magnitude of heat that the neonate might have been exposed to was investigated. A thermometer probe was placed 3 ft in front of the heater and temperatures were recorded over a 70 min period during the flow of hot air. The room temperature in the beginning was 35.4 °C. With the “Hot” button pressed the maximum temperature range of 49.7–50.7 °C was reached after 4 min, and with “Warm” button pressed the maximum temperature range of 51.2–52.2 °C was reached after 5 min. The temperature stabilized after the first few minutes with no further rise (Fig. 5). Thus this neonate was exposed to hot air of 51.2–52.2 °C for almost an hour.

3. Discussion

Patients undergoing surgery with general anesthesia are almost always poikilothermic intraoperatively and at risk of post-operative hypothermia. Hypothermia decreases host responses and thus increases the likelihood of wound infection and prolongs recovery. Without active warming, a patient's core temperature can potentially decrease by 1–1.5 °C in the first hour after induction.² Some external warming methods used to counteract this, however, may cause cutaneous burns. Burn injuries caused by convectors, fan heaters and mobile heaters have been recorded.³ Intravenous fluid bags or bottles warmed in the oven in the operating room also represent similar hazard to anesthetized patients. Surface application of warm intravenous fluid bags or bottles is not an efficient method of keeping the patient warm and there seems to be little justification for their use.¹ Generally fan heaters are considered to be incapable of causing burn injury.⁴ Placement of the fan heater directly on

the bed is considered dangerous. In the present case the 3 ft distance between neonate and fan heater was considered a safe distance. Safety instructions recommended by manufacturer were to place heater at least 3 ft away from objects like bedding, furniture, drapes, curtains, paper products, boxes and other combustible materials. Safe distance for humans was not mentioned. In the present case the 3 ft distance between neonate and fan heater was considered a safe distance. The skin surface of the neonate was subjected to the direct blow of hot air having temperature from 51.2 to 52.2 °C for about an hour, and the exposure to this temperature for even a very short duration can damage skin. In adults local cellular damage does not occur to a significant degree if the intensity of heat exposure to the skin is below 44 °C unless the exposure time is more than six hours. At temperatures between 44 °C and 51 °C at the skin surface and limited exposure time, the rate of cellular destruction doubles with each degree rise in temperature. At temperatures greater than 51 °C the epidermis is destroyed very rapidly. Above 70 °C total tissue destruction occurs within seconds.⁵ In the current case the swaddled cotton cloth was unable to prevent exposure of body surface to hot air. The swaddling cloth offered some insulation and the temperature of the hot air from the fan heater reaching the skin surface had decreased. Hence there was no third degree deep burn to that portion of the body which was covered with cloth. However, the body parts which were not swaddled with cloth sustained deep burns. Another important factor in this case is the delicate skin of the preterm neonate. The skin of a neonate, especially a preterm neonate, is more susceptible to damage.⁶ The epidermis is thinner in a premature neonate.⁷ Premature neonate also lacks the body fat necessary to maintain their core body temperature even when swaddled with blankets. Hence the skin of the neonate could be damaged even at less higher temperatures compared to adults even within short duration.

No prior incidence of similar injury occurred when used for managing post-operative hypothermia. For adult patients the heater was placed on a bedside trolley that was 3 ft higher than the bed height and with the hot air directed away from the patient. The fan heater had never been used for a neonate.

We recommend that for external warming, devices of proven efficacy and designed specifically for safe transfer of heat should be used for prevention and management of hypothermia.¹ Incubators or radiant warmers should be used to keep the neonate warm. Fan heater is not a safe device for management of hypothermia when placed at distance of 3 ft with the hot air directed towards body surface and swaddling cloth cannot offer full protection from the hot air. We also recommend that medical and paramedical staff be trained regarding appropriate use of these equipments. The principles and best practice recommendations about post-operative care must be followed scrupulously.

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